

**An Interactive Tool for Real Time Feedback on Diagnosis and Treatment Plan of Arthritis
Based on C++ Programing Language**

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of the Requirements for the Degree of*

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CERTIFICATE

This is to certify that the thesis titled, “**An Interactive Tool for Real Time Feedback on Diagnosis and Treatment Plan of Arthritis Based on C++ Programing Language**” submitted by Smriti Bhatt (Roll no. 110BM0540) in partial fulfillments for the requirement for the award Bachelor of Technology Degree in Biomedical Engineering during session 2010-2014 at National Institute of Technology, Rourkela and is an authentic work carried out by her under my supervision and guidance.

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TABLE OF CONTENTS

ACKNOWLEDGEMENT.....	3
LIST OF FIGURES	5
Abstract.....	6
Chapter 1	7
Introduction.....	7
Chapter 2	9
Literature.....	9
2.1 Articular versus Non-articular:	9
2.2 Inflammatory versus Non-inflammatory Disorders.....	10
2.3 Clinical History.....	13
2.4 Disease Description	14
2.5 Objectives	32
2.6 Research history in the field of arthritis.....	32
Chapter 3	33
3.1Methodology:.....	33
3.1.1 Work Plan:	33
Chapter 4	34
4.1 Programming/ Code:.....	34
Chapter 5 Results and Discussions.....	42
Chapter 6 Conclusions:	48

LIST OF FIGURES

SL. NO.	Content	Page No.
1.	Algorithm describing different types of arthritis	10
2.	Common musculoskeletal conditions	11
3.	A file photo showing different bones and joints	32
4.	Output interface for case study 1	46
5.	Output interface for case study2 [SLE]	47
6.	Output screen for case study 3 [reactive arthritis]	48

Abstract

Arthritis causes joint inflammation where body's immunity against disease or injury becomes overactive leading to swelling, pain and stiffness and it also can lead to tissue damage. Anatomically, arthritis usually affects the synovial joints in majority where the articular bones are covered by hyaline cartilages. The clinically significant arthritis are **Osteoarthritis, Rheumatoid Arthritis, Septic arthritis** and **Juvenile Arthritis** which features pain in the joints and typically worsen with age. Since the clinical burden due to arthritis is huge and due to the difficulties in proper differentiation and diagnosis of a particular arthritis, the examiner should determine the nature of the underlying pathologic process. Arthritis can be **infectious** (infection with *Neisseria gonorrhea* or *Mycobacterium tuberculosis*), **crystal-induced** (gout, pseudo-gout), **immune-related** [rheumatoid arthritis (RA), systemic lupus erythematosus (SLE)], **reactive** (rheumatic fever, Reiter's syndrome), or **idiopathic**. Current project imposes the use of C++ programming language in order to construct an interactive platform for the diagnosis and treatment of Arthritis. Huge amount of work has been done on various diseases to design a platform where on the basis of symptoms, diseases can be treated promptly; however, in the field of arthritis, study is lacking. Briefly, an algorithm was prepared for classifying the types of arthritis based upon the symptoms and signs as obtained from the patient. The algorithm was designed from the Harrison's principle of internal medicine with some modifications. An interactive platform was created by using on C++ programming language where recursive functions were used to call back arthritis specific symptoms in each step. Next, the algorithm was validated. It was concluded that the developed platform is highly interactive and assisted the rapid and accurate diagnosis of arthritis on the basis of symptoms input. Further, this platform can be integrated with electronics in order to form an embedded system so that people in rural areas may not suffer due to lack of facilities.

Keywords: Arthritis, Inflammatory disorders, Non-inflammatory disorders, Stiffness, Algorithm, C++ platform

Chapter 1

INTRODUCTION

More than 315 million patients suffer from musculoskeletal problems per year. Centers for Disease Control and Prevention recent surveys suggest that 33% (69.9 million) of the U.S [1]. population suffer from arthritis or joint disorders. Most of these are self-limited conditions that require minimal evaluation and only symptomatic therapy and reassurance. However, some of the particular musculoskeletal symptoms or their persistence in several patients may give rise to more severe conditions and problems that need further evaluation or laboratory testing to account for the required diagnosis and thereby documenting the nature and extent of pathologic phenomenon. The aim of the musculoskeletal evaluation is to create a differential diagnosis that results in an accurate and precise diagnosis and timely therapy, and thereby avoiding excessive diagnostic testing and unnecessary useless treatment. There are few conditions that must be diagnosed promptly in order to avoid significant morbid or mortal sequelae. These "red flag" or urgent diagnoses involves acute crystal-induced arthritis (e.g., gout), and septic arthritis and fracture. Every red flag may be suspected by its acute onset which does not seem so bad at first and non-articular presentation. People with musculoskeletal complaints should actually be evaluated by means of their chronological history, a comprehensive physical examination, and, if appropriate, laboratory testing. The word "**Arthritis**" means "**Joint Inflammation**" [2]. Inflammation can be defined as one of the body's natural reactions against disease or injury, and involves swelling, pain and stiffness. Inflammation that lasts for a very long time or repeatedly recurs, as in arthritis, may lead to damage of tissue. Arthritis can be categorized into two subclasses: inflammatory and non-inflammatory arthritis. Inflammatory arthritis pathway can be defined as a term used to describe a bunch of conditions which affect the immune system of body. This means that our body's defense system begin to attack our own tissues instead of germs, viruses and other foreign substances, which result in pain, joint damage and stiffness. They are also referred as autoimmune diseases. The three most typical forms of inflammatory arthritis are: Rheumatoid arthritis, Ankylosing Spondylitis and Psoriatic arthritis [3]. These conditions referred as systemic diseases as they can affect our whole body. They are not age specific. There is no cure for these types of diseases for now, but the outlook for people diagnosed with inflammatory arthritis is definitely better in compare to those 20-30 years ago.

Effective treatment for the disease begins much earlier and new drugs are available, which results in less joint damage, comparatively less need of surgery and fewer complications. Inflammatory arthritis is not the same as Osteoarthritis, which occurs when cartilage in the joints wears away. There are basically three ways to deal with typical Arthritis problems: the very first stage is **Tests and Treatments** and second stage includes **Surgeries** in severe cases and then third stage involves **Therapies** that is what we call post-ops procedure. One might need to go through a number of tests and diagnostic procedures to help the specialist team to decide on the best treatment for the patient. These tests includes: Blood tests, ultrasound scans, X-Rays and Disease Activity Scores. These tests could be a bit confusing to start especially when patient has just been diagnosed, but rheumatologist should help to explain them to the patient. Second section surgeries could be categorized into many sections.

1. **Foot and Ankle Surgery:** Most of the people with foot and ankle problems won't be needing surgery but if they do, it will help relieve pain and improve the function of feet.
2. **Hand and Wrist Surgery:** Surgery not necessary but in case if it is, it helps in relieving pain and to improvise the function of the hand.
3. **Hip Replacement Surgery:** Surgeon replaces the damaged surfaces with artificial parts during hip replacement surgery. It helps in reducing pain and improvises patient's mobility.
4. **Knee replacement Surgery:** More than 70,000 knee replacement operations are being carried out each year. They are usually recommended for Osteoarthritis but sometimes for inflammatory joint diseases.
5. **Shoulder and Elbow Replacement:** Shoulder and Elbow joint replacement includes the replacement of surfaces of the joint with parts made of metal and plastic. This process is referred as Arthroplasty.

Examples of some typical aches and pains are back pain, elbow pain, foot and ankle pain, hip pain, neck pain and shoulder pain. Therapies section looks precisely at how hydrotherapy, physiotherapy and occupational therapy helps with the arthritis problem explaining what to expect, the referral process and the benefits of each form of therapy.

Chapter 2

LITERATURE REVIEW

Patients with musculoskeletal complaints should be evaluated according to the chronological history, a comprehensive physical examination, and, if appropriate, laboratory testing. The initial encounter helps in determining whether the mentioned musculoskeletal complaint is (1) *articular* or *non-articular* in origin, (2) *acute* or *chronic* in duration (3) *inflammatory* or *non-inflammatory* in nature, and (4) *localized* or *widespread (systemic)* in distribution [4]. With such a precise and understanding approach of pathophysiologic processes that falls under the category of musculoskeletal complaints, a diagnosis can be performed on the huge majority of people. However, few patients may not fit immediately into the given established diagnostic criterion. Most of the musculoskeletal disorders resemble each other on the outside, and several may take weeks or months to evolve into a readily recognizable diagnostic entity.

2.1 Articular versus Non-articular:

The musculoskeletal evaluation should discriminate between the anatomic origins of the patient's complaint. For instance, ankle pain may be the consequence of a variety of pathologic conditions including gonococcal arthritis, calcaneal fracture, disparate anatomic structures, Achilles tendinitis, cellulitis, and peripheral neuropathy. Distinguishing between articular and non-articular conditions needs a precise and detailed examination [5]. Articular structures involve the synovium, synovial fluid, articular cartilage, intra-articular ligaments, joint capsule, and juxta-articular bone. Non-articular or peri-articular structures, such as supportive extra-articular ligaments, tendons, bursae, muscle, fascia, bone, nerve, and overlying skin, may be involved in the pathologic process. Although musculoskeletal complaints are often ascribed to the joints, non-articular disorders (rather than articular) more frequently underlie such complaints. Distinguishing between these potential sources of pain may be challenging to the unskilled examiner. Articular disorders may be characterized by deep or diffuse pain, pain or limited range of motion on active and passive movement, and swelling (caused by synovial proliferation, effusion, or bony enlargement), crepitation, instability, "locking," or deformity. By contrast, non-articular disorders tend to be painful on active, but not passive (or assisted), range of motion, demonstrate point or focal tenderness in regions adjacent to articular structures, and have

physical findings remote from the joint capsule. Moreover, non-articular disorders seldom demonstrate swelling, crepitus, instability, or deformity.

2.2 Inflammatory versus Non-inflammatory Disorders

In the course of a musculoskeletal evaluation, the examiner should determine the nature of the underlying pathologic process and whether inflammatory or noninflammatory findings exist. Inflammatory disorders may be infectious (infection with *Neisseria gonorrhoea* or *Mycobacterium tuberculosis*), crystal-induced (gout, pseudogout), immune-related [rheumatoid arthritis (RA), systemic lupus erythematosus (SLE)], reactive (rheumatic fever, Reiter's syndrome), or idiopathic [6]. Inflammatory disorders may be identified by any of the four cardinal signs of inflammation (erythema, warmth, pain, or swelling), systemic symptoms (fatigue, fever, rash, weight loss), or confirmation from research test center of inflammation [preeminent sedimentation rate of erythrocyte (ESR) or C-reactive protein (CRP), thrombocytosis, anemia of chronic disease, or hypoalbuminemia]. Articular stiffness commonly accompanies chronic musculoskeletal disorders. However, the severity and duration of stiffness may be diagnostically important. Morning stiffness related to inflammatory disorders (such as RA or polymyalgia rheumatica) is precipitated by prolonged rest, is described as severe, lasts for hours, and may improve with activity and anti-inflammatory medications [7]. By contrast, intermittent stiffness (also known as gel phenomenon), associated with noninflammatory conditions [such as osteoarthritis (OA)], is precipitated by brief periods of rest, usually lasts <60 min, and is exacerbated by activity. Fatigue may accompany inflammation (as seen in RA and polymyalgia rheumatica) but may also be prominent in fibromyalgia (a noninflammatory disorder), anemia, cardiac failure, endocrinopathy, poor nutrition, poor sleep, or depression. Noninflammatory disorders may be related to trauma (rotator cuff tear), repetitive use (bursitis, tendonitis), degeneration or ineffective repair (OA), neoplasm (pigmented villonodular synovitis), or pain amplification (fibromyalgia). Noninflammatory disorders are often characterized by pain without synovial swelling or warmth, absence of inflammatory or systemic features, daytime gel phenomena rather than morning stiffness, and normal (for age) or negative laboratory investigations.

Identification of the nature of the underlying process and the site of the complaint will enable the examiner to narrow the diagnostic considerations and to assess the need for immediate diagnostic or therapeutic intervention, or for continued observation [8]. Figure below presents a logical approach to the evaluation of patients with musculoskeletal complaints.

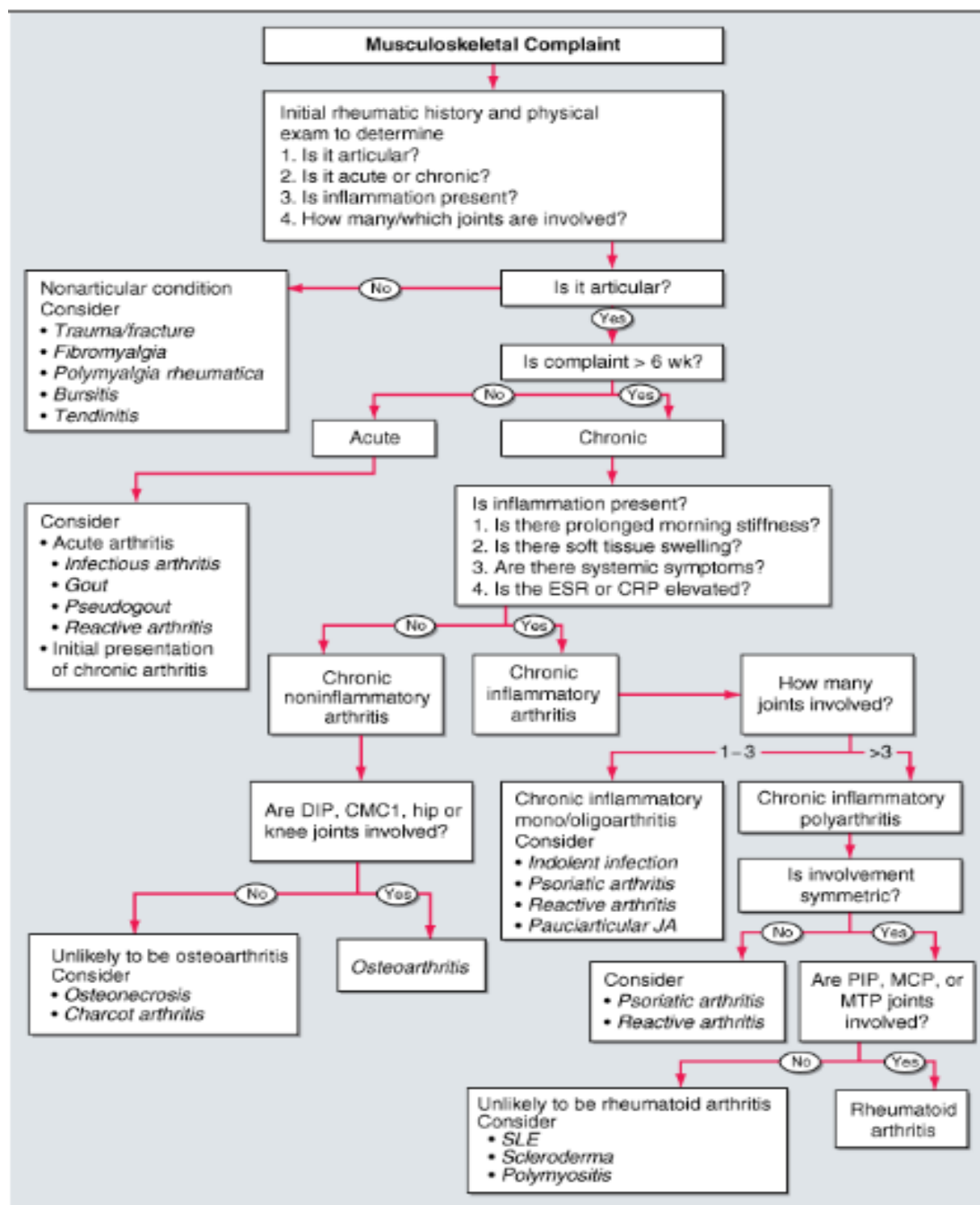


Figure1: Algorithm describing different types of arthritis

In the formulation of a differential diagnosis, the examiner should be mindful of the most common causes of musculoskeletal complaints (below figure). Thus, the prevalence of these disorders in the general population may facilitate an early diagnosis [9]. As trauma, fracture, and fibromyalgia are among the most common causes of presentation, these should be considered during the initial encounter. The frequency of these disorders is best clarified by dividing patients according to their age. Hence, those <60 years are commonly affected by repetitive use/strain disorders, gout (men only), RA, spondyloarthritis, and infectious arthritis. Patients >60 years are frequently affected by OA, crystal (gout and pseudogout) arthritis, polymyalgia rheumatica, osteoporotic fracture, and septic arthritis.

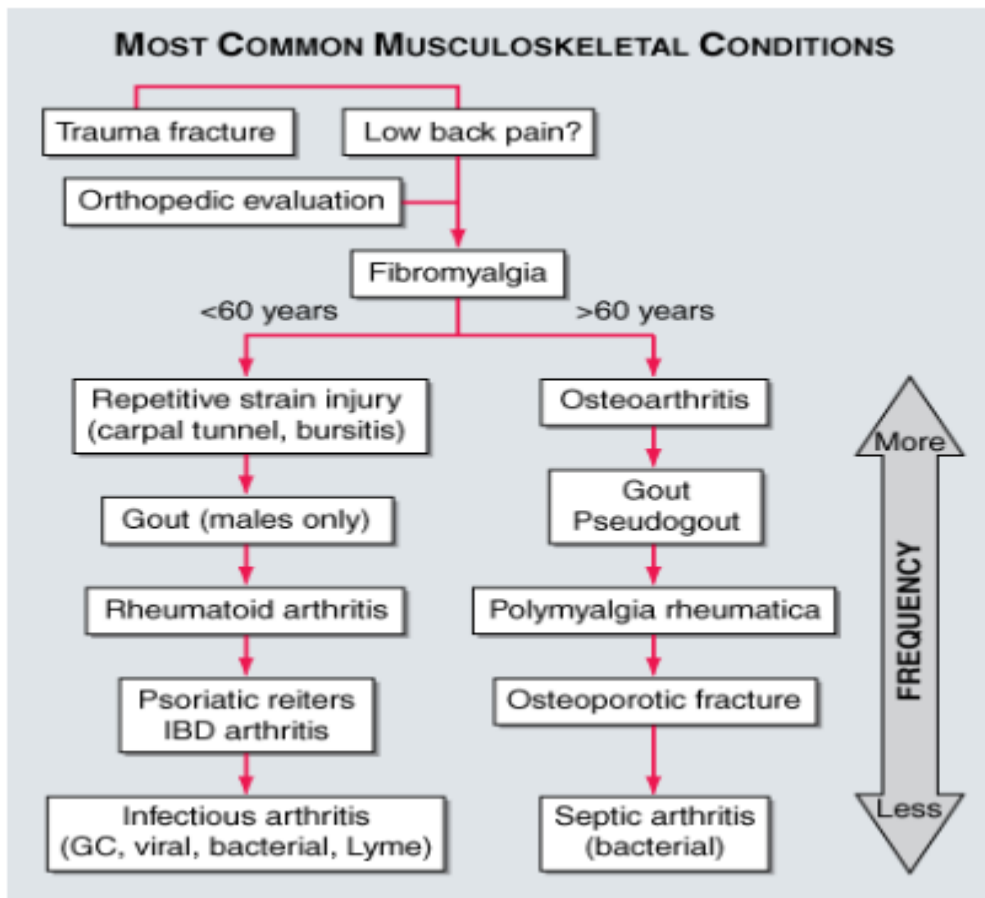


Figure 2: Common musculoskeletal conditions

2.3 Clinical History

Additional historic features may reveal important clues to the diagnosis. Aspects of the patient profile, complaint chronology, extent of joint involvement, and precipitating factors can provide important information. Certain diagnoses are more frequent in different age groups (Fig. 325-2). SLE and reactive arthritis occur more frequently in the young, whereas fibromyalgia and RA are frequent in middle age and OA and polymyalgia rheumatica are more prevalent among the elderly. Diagnostic clustering is also evident when sex and race are considered. Gout and the spondyloarthropathies (e.g., ankylosing spondylitis) are more common in men, whereas RA, fibromyalgia, and lupus are more frequent in women [10]. Racial predilections may be influential. Thus, polymyalgia rheumatica, giant cell arteritis, and Wegener's granulomatosis commonly affect whites, whereas sarcoidosis and SLE more commonly affect African Americans. Familial aggregation may be seen in disorders such as ankylosing spondylitis, gout, and Heberden's nodes of OA.

The chronology of the complaint is an important diagnostic feature and can be divided into the onset, evolution, and duration [11]. The onset of disorders such as septic arthritis or gout tends to be abrupt, whereas OA, RA, and fibromyalgia may have more indolent presentations. The patients' complaints may evolve differently and be classified as chronic (OA), intermittent (crystal or Lyme arthritis), migratory (rheumatic fever, gonococcal or viral arthritis), or additive (RA, psoriatic arthritis) [12]. Musculoskeletal disorders are typically classified as acute or chronic based upon a symptom duration that is either less than or greater than 6 weeks, respectively. Acute arthropathies tend to be infectious, crystal-induced, or reactive. Chronic conditions include non-inflammatory or immunologic arthritis (e.g., OA, RA) and non-articular disorders (e.g., fibromyalgia).

The extent of articular involvement is often diagnostic. Articular disorders are classified based on the number of joints involved, as monoarticular (one joint), oligoarticular or pauciarticular (two or three joints), or polyarticular (more than three joints). Although crystal and infectious arthritis are often mono- or oligoarticular, OA and RA are polyarticular disorders [13]. Nonarticular disorders may be classified as either focal or widespread. Complaints secondary to tendinitis or carpal tunnel syndrome are typically focal, whereas weakness and myalgia, due to polymyositis or fibromyalgia, are more diffuse in their presentation. Joint involvement in RA tends to be symmetric, whereas the spondyloarthropathies and gout are often asymmetric and

oligoarticular. The upper extremities are frequently involved in RA and OA, whereas lower extremity arthritis is characteristic of reactive arthritis and gout at their onset. Involvement of the axial skeleton is common in OA and ankylosing spondylitis but is infrequent in RA, with the notable exception of the cervical spine.

2.4 Disease Description

According to **figure 1**, below is the list of some of the possible types of Arthritis that occurs in most of the musculoskeletal problems.

1. Acute Arthritis: Acute Arthritis can first present as a symptom of dangerous and rapidly progressing disease. It is quite easy to differentiate between arthritis and peri-arthritis. More problematical is correct and early differential diagnosis of the acute arthritis. Determining whether one, several or many joints are affected can narrow the diagnostic possibilities. Arthrocentesis and synovial fluid testing provide much of fever; rash, family history of joint disease and exposure to infective organisms can further direct diagnostic studies and treatment [14].

Examination of Acute Arthritis

- 1. General:** Check temperature, pulse and blood pressure. Establish whether the patient appears to be suffering from sepsis. Check to see if there is pharyngitis. Look at the nails folds and listen to the heart if possible rheumatic fever.
- 2. Eyes:** Check for inflammation there.
- 3. Skin:** Check to see if there is any rash. Examine the extensor aspects of the forearms for nodules and the shins for evidence of erythema nodosum. Check whether there are gouty tophi.

Erythema nodosum is a type of skin inflammation that is located in a part of the fatty layers of skin [14]. It results in reddish, painful, tender lumps most commonly located in the front of the legs below the knees. The tender lumps or nodules, of erythema nodosum range in size from a dime to a quarter [15].

- 4. Joint examination:** When examining the affected joint, first inspect it for evidence of any deformity, swelling, erythema, peri-articular muscle wasting or evidence of overlying bursitis.

Palpate to discern if swelling is due to bony enlargement, synovial thickening or effusion [16]. If effusion is suspected, confirm it by testing for fluctuance or patellar tap in knee joint.

Test the active and passive movements of the joint. Note if there is pain or crepitus for each.

If the affected joint is prosthetic, examine the skin carefully for evidence of abscess or sinus information.

Do not forget to examine other joints that may be the cause of symptoms-eg, hip causing knee symptoms. If the painful and surrounding joints are normal on examination, consider referral from other pain source-eg, shoulder pain caused by cardiac/gall bladder pathology [17].

2. **Infectious Arthritis:** It is form of arthritis that is produced by an infection. Also known as “septic arthritis” [18]. Unlike other types of arthritis, it is not usually long term illness. Treated promptly and properly it is generally a curable form of Arthritis.

Symptoms of Infectious Arthritis:

1. Severe pain that worsens with movement.
2. Swelling of the joint.
3. Warmth and redness around the joint.
4. Fever
5. Chills
6. Fatigue
7. Weakness
8. Decreased appetite
9. Rapid heartbeat
10. Irritability

Diagnosis of Infectious Arthritis

1. **Arthrocentesis:** It is a test frequently used to diagnose this condition. It involves inserting a needle into the affected joint to take a sample of synovial fluid [19]. The sample is sent to the lab to be examined for color, consistency and the presence of

white blood cells and bacteria. The information from this test can tell your doctor, if you have an infection in the joint, and what is causing the infection.

2. **Blood Sample** to check out the white blood cell count and to determine the presence of bacteria in bloodstream. It helps in determination of how serious the infection is.
3. **Imaging Tests** may also be ordered to confirm the presence of infection. It also helps to see if your joint has been damaged by the infection. Imaging tests used for this purpose are X-ray, MRI, CT Scans and Nuclear Scans.

Treatment for Infectious Arthritis

1. **Prescription Drugs:** These are of two types: Antibiotics medication and Antifungal medication.

Antibiotics medication can be further categorized into two sections: Antibiotics intravenously and Oral Antibiotics. Antibiotics IV treat the infection more quickly than oral antibiotics. Most individuals begin to feel better within 48 hours of their first antibiotic treatment. Whereas Oral Antibiotics usually takes six to eight weeks [20]. It is important to take the entire course of antibiotics to treat the infection effectively.

Antifungal medication is prescribed instead of antibiotics medication if infection is caused by fungal infection.

2. **Synovial fluid drainage:** Many individuals with infectious arthritis need to have their synovial fluid drained. This is done to remove the infected fluid, ease pain and swelling, and increase the speed of recovery. There are two methods to drain the synovial fluid:
 1. **Arthroscopy:** Most often used. Several small incisions are made near the affected joints. A small tube is fed containing a camera into the incision. Camera image is used to guide in suctioning the infected fluid from your joint.
 2. **Arthrocentesis:** It uses a small needle to remove infected fluid without requiring surgery. This procedure often has to be repeated over the course of several days to ensure enough fluid is drained.

Other treatment options:

Rarely more severe cases of infectious arthritis require surgery to wash out the joint, remove damaged sections of the joint or replace the joint.

Other treatment methods to reduce the pain may be used in conjunction with treatment of the infection. These methods include:

1. Using non-steroidal anti-inflammatory medications [NSAIDs]
2. Resting the joint.
3. Applying heat to the joint.
4. Splinting the affected joint.
5. Physical therapy.

3. **Osteoarthritis:** Cartilage cushions bones at the joints and keeps the bones from rubbing each other. Osteoarthritis [OA] occurs when this cartilage wears away. The loss of cartilage results in pain, reduced range of motion, and swelling. The condition is also known as “wear and tear” arthritis [21].

Signs and symptoms of OA:

1. Joint Pain
2. Morning stiffness lasting less than 30 minutes.
3. Joint instability or buckling
4. Loss of function
5. Bony enlargement at affected joints.
6. Limitation of range of motion.
7. Crepitus on motion.
8. Pain with motion
9. Malalignment and/or joint deformity.

Pattern of joint involvement

Axial: Cervical and lumbar spine

Peripheral: Distal interphalangeal joint, proximal interphalangeal joint, first carpometacarpal joints, knees, hips.

4. Rheumatoid Arthritis:

It is an autoimmune disease in which the immune system of our body attacks the body itself.

The abnormal immune response causes inflammation that can damage joints and organs such as the heart [22]. Early diagnosis and prompt treatment is the key to preventing joint destruction and organ damage.

Symptoms:

1. Joint inflammation (small joints of hands and fingers, wrists, feet and knees).
2. Tenderness
3. Swelling and deformity
4. Skin for rheumatoid nodules
5. Other parts of body inflamed
6. Weight loss
7. Loss of appetite
8. General weakness.

Diagnosis and Medical Tests:

For Rheumatoid Arthritis there is no specific medical test which can determine positive result [3]. Sometimes patients with RA show abnormal test results, whereas for few patients, all tests report comes out to be normal.

Lab tests that often used for RA diagnosis:

1. Anti-CCP antibody test.
2. Rheumatoid factor test

Few more tests that can be used as diagnosis:

1. C-Reactive Protein
2. Erythrocyte sedimentation rate
3. Synovial fluid analysis
4. Joint ultrasound or MRI
5. Complete blood count.
6. Joint X-Rays

Treatment for Rheumatoid Arthritis (RA):

It's a lifelong treatment, including regular medications, exercise, physical therapy, surgery and proper education. Early aggressive treatment for RA can delay joint destruction.

1. **Analgesics [Relieve pain]:** These pills are utilized for agony easing and don't have any impact on aggravation [23]. Analgesics may be better endured by the individuals

who are unable to take NSAIDs as a result of anaphylaxes and stomach issues. A case of over-the-counter analgesics is Acetaminophen, which is accessible without a remedy. Medicine analgesics are additionally accessible.

2. **NSAIDs and Steroids [Relieve pain and reduce inflammation]:** Non-steroidal hostile to incendiary Drugs (NSAIDs) [24]. These medications are utilized to diminish ache and aggravation of joint pain. They don't hold steroids. Cases are Ibuprofen and ASA and they are accessible either over the counter or with a medicine. It is essential to recall that these solutions work to enhance indications however don't change the course of the ailment or avert joint demolition.

Steroids: Cortisone is the hormone handled commonly by the body's adrenal organs that manages the routine irritation from minor damages [25].

3. **DMARDs [Relieve pain and slow joint damage]:** Infection altering hostile to rheumatic pills are a class of medicine that smother aggravation and may help to avoid harm to the joint. They can possibly abate infection movement, potentially save joint capacity. DMARDs are accessible by solution just and incorporate prescriptions like methotrexate. At times patients who don't react to one DMARD may be dealt with consecutively with an alternate DMARD or with a mixture of DMARDs.
4. **Biologic Response Modifier [Targeted treatment to relieve pain and inflammation. Some can help to prevent damage to the joints.]** They help diminish torment and smother irritation and counteract harm to the joints. Some biologic treatments can likewise be utilized within mixture with DMARDs.

5. SLE (Systemic Lupus Erythematosus):

It is a systemic immune system connective tissue illness that can influence practically all aspects of human body. Our resistant framework assaults our own particular body cell's tissue that prompts irritation and tissue harm. It is both a sort II and a sort III extreme touchiness response in which invulnerable complex encourage and reason a further resistant reaction. SLE is very regular in ladies than men. It may happen just about at any age, however the greater part of the cases show up in the middle of the ages of 10 and 50. African Americans and Asians are generally influenced in contrast with the individuals from different races.

Symptoms and Diagnosis:

1. Rash on the bridge of the nose and cheeks, often known as butterfly rash.
2. Raised red patches on the skin called as Discoid rash.
3. Sensitivity to sunlight or photosensitivity.
4. Mouth or nose ulcers.
5. Arthritis
6. Heart or lung changes
7. Nervous system changes
8. Kidney changes
9. Blood changes
10. Antibodies in DNA
11. ANA present in the blood
12. Swollen lymph nodes

Exams and tests

Tests used to diagnose SLE may include:

1. Antibody tests, including antinuclear antibody (ANA) panel.
2. CBC
3. Chest x-ray
4. Kidney biopsy
5. Urinalysis

Treatments for SLE

1. **NSAIDs** reduce the inflammation responsible for the stiffness and discomfort in your muscle, joints and other tissues.
2. **Anti-malarial drugs- plaquenil:** [hydroxychloroquine] Medicine for malaria helps in controlling lupus.
3. **Corticosteroids:** Prednisone and other types of corticosteroids can counter the inflammation of lupus.
4. **Immune Suppressants:** such as Belimumab (Benlysta), mycophenolate mofetil, cyclosporine, Cytoxan, Imuran, and Methotrexate [26]. These are used in very serious case of lupus i.e., where lupus is very active.
5. Various medications for skin condition related to lupus.

6. Scleroderma:

Scleroderma is a reasonably uncommon condition creating regions of skin to get hard and thick, which might additionally influence interior organs [27]. It is an immune system illness in which the body's resistance wrongly turns on its skin and tissue. This ailment for the most part influences individuals of age from 30 upto 50 years of age. Ladies are more susceptible scleroderma than men do. In some cases scleroderma influence just the skin, while at times influences the entire body [28].

Two sorts of scleroderma exist:

1. Localized Scleroderma: It impacts the skin on the hands and face. It makes bit by bit, and on occasion spreads in the body or reasons real issues.
2. [Sclerosis] Systemic Scleroderma: It may affect considerable portions of skin and organs, for instance, the lungs, kidneys and the heart. There exist two primary sorts:
 - a. limited illness [crest Syndrome]
 - b. diffuse illness.

Psoriatic Arthritis

The primary medicine is with corticosteroid prescriptions [29]. The measurement of solution is gradually decreased as muscle quality makes strides. This takes something like 4-6 weeks. You will stay on a low measurement of a corticosteroid medication after that. Prescriptions to smother the insusceptible framework, for example, methotrexate and azathioprine, may be utilized for individuals who don't react to corticosteroids.

Intravenous gamma globulin has been endeavored, with blended outcomes. Biologic medications likewise may have influence in treating this condition however it is so soon it is not possible know. In the event that the condition is connected with a tumor, it may enhance if the tumor is evacuated.

Symptoms:

Doctors first look for common signs and symptoms:

1. general fatigue

2. tenderness, pain and swelling over tendons
3. swollen fingers and toes
4. stiffness, pain, throbbing, swelling and tenderness in one or more joints
5. reduced range of motion
6. morning stiffness and tiredness
7. nail changes – for example, the nail separates from the nail bed and/or becomes pitted and mimics fungus infections
8. Redness and pain of the eye, such as conjunctivitis.

There are five sorts of psoriatic joint pain. It is vital to know which sort of psoriatic joint pain you have and to comprehend its attributes so it may be dealt with legitimately.

1. **Symmetric Psoriatic Arthritis:** Symmetric psoriatic joint pain influences the same joints- more often than not in various matching sets on both sides of the body [30]. Symmetric psoriatic joint pain might be handicapping, bringing on fluctuating degrees of dynamic, dangerous sickness in half of individuals with this kind of joint pain. Despite the fact that symmetric psoriatic joint pain looks like rheumatoid joint pain, it is by and large milder [31].
2. **Asymmetric Psoriatic Arthritis:** Asymmetric psoriatic joint pain regularly includes one to three joints in the body- extensive or little, for example, the knee, hip or one or a few fingers. Uneven psoriatic does not influence matching sets of joints on both sides of the body.
3. **Distal Interphalangeal Predominant (DIP):** Distal Interphalangeal dominating joint inflammation includes fundamentally the little joints in the fingers and toes closest to the nail. DIP is now and again confounded with Heberden's hubs brought about by Osteoarthritis, an incessant sickness that causes the crumbling of joint cartilage and tissues and bone goads at the joints.

4. **Spondylitis:** Spondylitis influences the spinal segment, and can result in solidness and irritation in the neck, sacroiliac area (pelvic region), spinal vertebrae and lower again by making issue in movement. It might additionally influence connective tissue, for example, ligaments, or reason joint illness in the joints of the arms, hips, feet or legs.
5. **Arthritis Mutilans:** It is the most disfiguring and ruinous manifestation of psoriatic joint inflammation that fundamentally influences the little joints in the fingers and toes closest to the nail additionally is frequently connected with neck agony and lower back torment. This sort is extremely normal.

Treatment:

There is no cure for psoriatic arthritis. The aim of treatment is to reduce the joint pain and swelling, preserve joint function, slow or prevent joint damage and control psoriasis on the skin.

1. **NSAIDs:** they do a good job of reducing pain, swelling and inflammation. But they may result in stomach distress and ulcers or increase the risk of heart attack in some people.
2. **Oral and injectable corticosteroids:** They control inflammation, but are not recommended for frequent and long term use.
3. **DMARDs:** They are often prescribed because they are biologic response modifiers.
4. **Physical Therapy**
5. **Heat and cold treatments.**

9. Reactive Arthritis:

Reactive arthritis, formerly referred to as Reiter's syndrome, is a type that affects the joints, eyes, urethra (the tube that carries urine from bladder to the outside of the body), and the skin [32]. It primarily affects sexually active males between the ages of 20 and 40. Those with HIV (human immunodeficiency virus) are at a particularly high risk. The causes of reactive arthritis are still unknown, but research suggests the disease is caused

in part, by a genetic predisposition: approximately 75% of those with the condition have a positive blood test for the genetic marker HLA-B27.

In sexually active males, most cases of reactive arthritis follow infection with *Chlamydia trachomatis* or *Ureaplasma urealyticum*, both sexually transmitted diseases. In other cases, people develop the symptoms following an intestinal infection with shigella, salmonella, *Yersinia*, or campylobacter bacteria. Besides using condoms during sexual activity, there is no known preventive measure for reactive arthritis.

Symptoms:

Starting indications of receptive joint inflammation are tormenting pee and a release from the penis if there is aggravation of the urethra. The runs might additionally happen if the intestinal part is influenced, trailed by joint pain about 4 to 28 days after the fact which generally influences the fingers, toes, lower legs, knee joints and hips. Normally one and only or a couple of these joints may be influenced at one time. Other symptoms include:

1. Mouth ulcers
2. Inflammation of the eye
3. Keratoderma blennorrhagica (patches of scaly skin on the palms, soles, trunk, or scalp)
4. Back pain from sacroiliac joint involvement
5. Pain from inflammation of the ligaments and tendons at the sites of their insertion into the bone (enthesitis).

Diagnosis and Tests:

A solitary test can't affirm that somebody have touchy joint pain. The judgment is focused around the extraordinary indications took after by a disease. Then again, tests like blood tests and X-beams is possible so as to affirm the vicinity of different sorts of joint pain, for example, gout or rheumatoid joint pain.

Tests:

1. Stool sample (sample of faeces) in case of gut infection as a trigger. But it might have been gone before arthritis develops.

2. You and your sexual partner may be referred to a genito-urinary clinic to check for sexually transmitted infections if urethritis is suspected as the trigger. You should avoid having sex (including oral sex) until you and your partner have completed treatment and follow-up for any genital infection that has been found.
3. Other tests for triggering infections may be done if any are suspected.
4. You may be referred to an eye specialist if your doctor suspects that you have uveitis.

Treatment Procedure:

1. Treatment for promptly organize: The intense aggravation could be treated with non-steroidal mitigating pills (frequently alluded to as NSAIDs). These pills stifle the swelling and torment experiencing and the measurement fluctuates patient to patient. A percentage of the illustrations of this pill are: naproxen (Aleve), diclofenac (Voltaren), indomethacin (Indocin) or celecoxib (Celebrex). Symptoms of this pill may bring about gastrointestinal digressions.
2. Treatment for late stage: Chronic receptive joint inflammation may be treated with an infection altering hostile to rheumatic pill (DMARDs). Samples are sulfasalazine or methotrexate. In the event that when receptive joint pain is activated by GI disease, Sulfasalazine is utilized.

In some different cases, extremely aroused joints may better be dealt with from corticosteroid infusions (cortisone shots).New research proposes that a delayed course of two or more anti-microbial may be viable in patients with constant Chlamydia-impelled sensitive joint pain.

Points to Remember:

1. If you develop arthritis within one month of diarrhea or a genital infection-especially with a discharge-see a health care provider. You may have reactive arthritis.
2. Most cases of reactive arthritis appear as a short episode. Occasionally, it becomes chronic.
3. Effective treatment is available for reactive arthritis.

10. Indolent Infection:

11. Pauciarticular JA [Juvenile Arthritis]:

It is the minimum extreme and most regular manifestation of JA and influences about 40% to 60 % of all JA patients. It generally influences around four joints: knee, lower leg, wrist and elbow. In spite of the fact that it doesn't meddle with the patient's development. Something like 15% of patients with this type of JA wind up with distorted joints. It frequently influences the joint on one side of the body just, especially the knee. It might likewise cause eye aggravation (uveitis) which is most oftentimes found in youngsters with positive ANA. Otherwise called Oligoarticular JIA.

Symptoms:

1. Persistent joint swelling, pain and stiffness that is typically worse in the morning or after a nap.
2. Limited movement of the affected joint.
3. Limping in the morning because of an affected knee.
4. Eye inflammation (Iritis or uveitis).
5. Growth problems in some of the cases.
6. Unexplained skin rashes.
7. Fever associated with swelling of Lymph Nodes.

12. Gout and Pseudogout:

Crystal induced arthropathies. Gout is monosodium urate monohydrate crystals.

Pseudogout is calcium pyrophosphate crystals.

Symptoms:

1. **Podagra:** 50% in Gout and 90% in Pseudogout.

2. **Arthritis** in other sites: Pseudogout (large joints) and Gout (ankle, wrist, finger and knee joints.)
3. **Inflammation**
4. **Fever**
5. **Tophi** in soft tissues.
6. **Eye** involvement

Diagnosis:

1. Serum uric acid measurement
2. Joint aspiration and synovial fluid analysis.

Treatments:

1. **NSAIDs** : example Indomethacin
2. Corticosteroids: example, colchicine and ACTH
3. Therapies.

13. Polymyalgia Rheumatica:

It is a condition that understands the irritating of joints and tissues around the joints. It signifies "torment in different muscles". This concludes in the throb and strength in muscles, particularly around the shoulder, neck and hip spaces.

Symptoms:

The main symptoms are:

1. Muscle pain and stiffness in the upper arms, neck, buttocks and thighs on both sides of the body.
2. Pain and stiffness worse in the morning and after taking rest for a period of time.
3. Difficulty in sleeping and doing daily activities due to pain and stiffness.

Diagnosis and Tests:

There is no single test that aide in the analysis of polymyalgia rheumatic. It might be diagnosed on the premise of manifestations, physical examination and blood tests that measures the level of irritation.

1. ESR Test [erythrocyte Sedimentation rate]
2. CRP blood level [c-receptive protein].

Other test outcomes for this condition include:

1. Abnormal proteins in the blood
2. Abnormal white platelets
3. Anemia (low blood number)

These tests can additionally be utilized to screen patient's condition.

Treatment: There is no cure for polymyalgia rheumatic. Low measurements of corticosteroids, (for example, prednisone) are helpful once in a while however it ought to be lessened to a low level, and medicine needs to proceed for about 2-6 years.

14. Fibromyalgia:

It is a non-life undermining, intense issue with far reaching ache as its principle side effect. Now and again it has been characterizes as feeling like a tenacious influenza. The reason for fibromyalgia is obscure however there are a percentage of the conceivable causes that triggers the fibromyalgia are:

1. physical or passionate trauma
2. abnormal agony reaction ranges in the mind that are answerable for torment can respond not the same as different patients
3. sleep aggravations
4. Infection, for example, infection.

It is most common among the women aged 20 to 50 years.

Symptoms:

1. Chronic muscle pain, muscle spasms, or tightness
2. Moderate or severe fatigue and decreased energy
3. Insomnia or waking up feeling just as tired as when you went to sleep
4. Stiffness upon waking or after staying in one position for too long.
5. irritable entrails syndrome (IBS)
6. memory and fixation issues
7. numbness and shivering in hands and feet

8. reduced capability to work out
9. tension or headache migraines

Exams and Tests:

To be diagnosed with fibromyalgia, one must experience the ill effects of at least 3 months of far reaching agony, and likewise torment and delicacy in arms, backside, midsection, rib enclosure, shoulders, thighs, lower back, neck and knees. Blood and pee tests ought to be carried out to discount the conceivable outcomes of different sorts of joint inflammation.

Treatment:

1. Physical Therapy
2. Exercise and fitness program
3. Stress relief methods, including light massage and relaxation techniques
4. Some of the medicines specifically approved for fibromyalgia are Duloxetine (Cymbalta), pregabalin (Lyrica), and milnacipran (Savella).

15. Osteonecrosis:

It is destruction of bone achieved by poor blood supply. Most customarily happens in the hip and shoulder, also impacts other far reaching joints, for instance, the knee, elbow, wrist and more level leg. It happens when some a piece of the bones does not get legitimate supply of blood and they bites the dust. Before long the bone may fall. On the off chance that it is not treated legitimately, the joint weakens, prompting serious joint pain.

Symptoms:

No side effects are found in the early stages. Be that as it may as bone harm declines, one may show taking after indications:

1. Pain in the joints that may build over the long haul and gets serious when bone breakdown
2. Limited extent of movement
3. Groin ache, if the hip joint is influenced
4. Limping if the condition happens in or underneath the hips.

Treatment:

In right on time stage torment relievers and by constraining utilization of the influenced zone is valuable. Non- surgical medicine may back off the procedure of osteonecrosis, yet most individuals will require surgery:

1. A bone joining
2. A vascularized bone joining (bone union with blood supply).
3. Cutting the bone and transforming its arrangement to assuage stretch on the bone or joint (Osteotomy)
4. Total joint substitution
5. Removing a piece of within the bone (center decompression) to diminish weight and permit fresh recruits vessels to structure.

Precautions:

The majority of the instances of osteonecrosis, reason is obscure and hence avoidance may not be conceivable. In any case in a portion of the cases, danger might be decreased by the accompanying methodology:

1. By avoiding drinking excessive alcohol
2. By avoiding high doses and long term uses of corticosteroids
3. Dive safely in order to avoid decompression sickness.

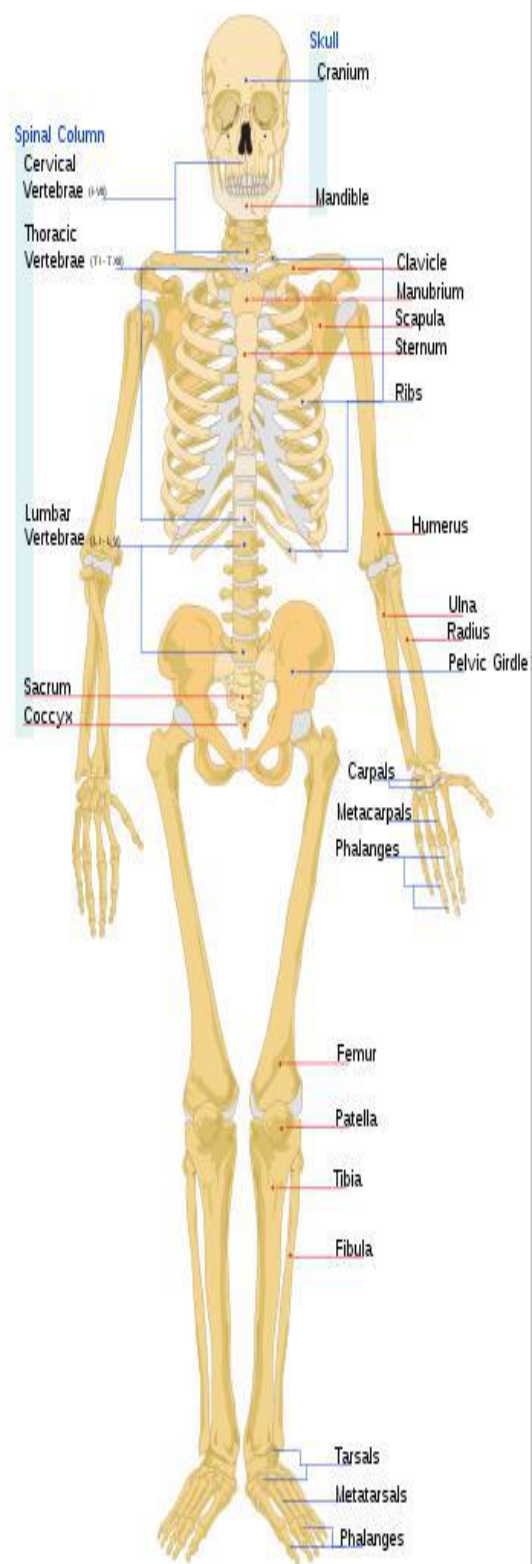
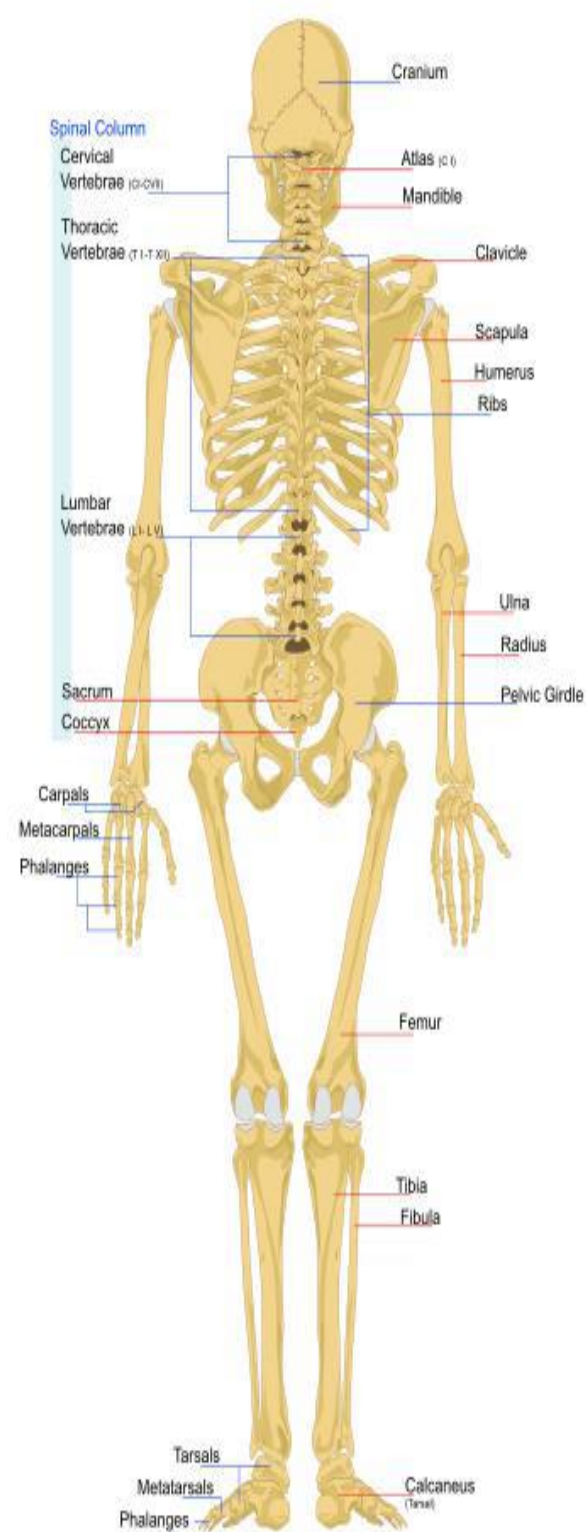


Figure 3: A file photo showing different bones and joints

2.5 Objectives

1. Diagnosis and treatment procedure of Arthritis
2. Using C++ platform an algorithm was designed.
3. Three case studies for different type of arthritis were performed effectively using the above algorithm.

2.6 Research history in the field of arthritis

One may need to experience various tests to help the master group choose the best medication accessible for that sort of joint inflammation. These tests includes: blood tests that affirms the vicinity of irritation at the site of joints, X-beams, Ultrasound outputs and Disease movement scores. There exist numerous sorts of treatments: Hydrotherapy, word related help and physiotherapy that can help with the joint inflammation for every day employments.

Hydrotherapy is utilized to help simplicity torment and enhance portability in the joints of the individuals with joint pain and related condition. Word related treatment help in discovering methods for proceeding with the day by day work, family unit errands, individual mind and interests freely and without putting strain on the joints. Physiotherapy serves to keep the body moving and gives the certainty to keep working out. Surgeries are pertinent in the most exceedingly bad situation or serious instances of joint inflammation. In spite of all the accessible strategies and medication measures to manage joint inflammation, this field still fails to offer the accessibility of medicine systems to manage. Reason for a large portion of the joint pain is still obscure however heaps of examination is as of now going ahead in this field.

Chapter 3

3.1 Methodology:

Methodology of this plan is given below:

3.1.1 Work Plan:

1. Research and study of Arthritis and its types, symptoms, diagnostic procedure and treatment.
2. Algorithm Design on the basis of research work to rule out the possibility of type of arthritis.
3. Programming using C++ language to form a platform for computer user interface.
4. Application or execution of platform for different people for evaluation of work.

Chapter 4

4.1 Programming/ Code:

```
#include<iostream>
#include<string>
using namespace std;
void Rheumatoid_arthritis();
void SLE();
void Polymyositis();
void Scleroderma();
int main()
{
    int age, noj;
    char p_name[20], G[5], race[10], art, time, inflam, sym, PMM;
    cout<<"Enter Patient details\n"<<"1. Patient's name: \n";
    gets(p_name);
    cout<<"2. Gender: \n";
    gets(G);
    cout<<"3. Race: \n";
    gets(race);
    cout<<"4. Age: \n";
    cin>>age;
    cout<<"articulation involvement? \n"<<"Enter Yes/No: \n";
    cin>>art;
    if(art=='Y' || art=='y')
    {
        cout<<"Pain, swelling and tenderness in bone involved"<<endl;
        cout<<"Is suffering more than 6 weeks? \n";
        cin>>time;
        if(time=='Y' || time=='y')
        {
            cout<<"Is inflammation present?"<<endl;
            cout<<"Check for inflammation: \n";
            cout<<"1. Prolonged Morning sickness? \n";
            cout<<"2. Soft Tissue swelling? \n";
            cout<<"3. Systemic symptoms: \n";
            cout<<"4. ESR or CRP elevated? : \n";
            cin>>inflam;
            if(inflam=='Y' || inflam=='y')
            {
                cout<<"Possibility of Chronic inflammatory arthritis"<<endl;
                cout<<"check for other criterions____"<<endl;
                cout<<"how many joints are involved?: "<<endl;
                cin>>noj;
                if(noj>3)
                {
```

```

cout<<"It is a case of Chronic inflammatory Polyarthrititis: \n";
cout<<"Is involvement symmetric? : "<<endl;
cin>>sym;
if(sym=='Y' || sym=='y')
{
cout<<"check for the possibility of rheumatoid arthritis"<<endl;
cout<<"Are PIP, MCP or MTP joints involved?"<<endl;
cin>>PMM;
if(PMM=='Y' || PMM=='y')
{
cout<<"It is Rheumatoid Arthritis"<<endl;
Rheumatoid_arthritis();
}
else
{
cout<<"Unlikely to be RA: consider 1. SLE 2. Scleroderma 3. Polymyositis"<<endl;
SLE();
Scleroderma();
Polymyositis();
}
else
{
cout<<"Consider: 1. Psoriatic Arthritis 2. Reactive Arthritis"<<endl;
}
else
{
cout<<"It is Chronic Inflammatory mono/oligo Arthritis"<<endl;
cout<<"Possibilities are: 1. Indolent Infection 2. Psoriatic Arthritis 3. Reactive Arthritis 4.
Pauciarticular JA"<<endl;
}
else
{
cout<<"It is a case of Chronic non-inflammatory Arthritis"<<endl;
}
else
{
cout<<"Non-articular condition: \n";
cout<<" 1. Trauma/Fracture 2. Fibromyalgia 3. Polymyalgia rheumatic 4. Bursitis 5.
Myositis"<<endl;
}
}

```

```

return 0;
}
void Rheumatoid_arthritis()
{
int i=0;
char ji, sym, PST, r_nod, wgl;
cout<<"check for the symptoms of Rheumatoid Arthritis: \n";
cout<<"Enter Y/N for the below queries:"<<endl;
cout<<"Is patient suffering from Joint Inflammation? \n";
cin>>ji;
if(ji=='Y' || ji=='y')
{
i=i+1;
}
cout<<"Pain,swelling, tenderness and reddishness in joints? \n";
cin>>PST;
if(PST=='Y' || PST=='y')
{ i=i+1;
}
cout<<"Symmetricity in inflammation or Joints on both the sides of the body are affected? \n";
cin>>sym;
if(sym=='Y' || sym=='y')
{ i=i+1;
}
cout<<"Skin for rheumatoid nodules? \n";
cin>>r_nod;
if(r_nod=='Y' || r_nod=='y')
{ i=i+1;
}
cout<<"Weight loss, general weakness and loss of appetite? \n";
cin>>wgl;
if(wgl=='Y' || wgl=='y')
{
i=i+1;
}
if(i>=3)
{ char RFT,ACAT;
cout<<"It is rheumatoid arthritis. Kindly go for the listed tests to confirm it properly \n";
cout<<"1. Rheumatoid Factor test  2. Anti-CCP antibody test \n";
cin>>RFT>>ACAT;
if(RFT=='P' || RFT=='p' || ACAT=='P' || ACAT=='p')
{
cout<<"Follow the below procedure for the treatment of Rheumatoid Arthritis: \n";
cout<<"1. Analgesics to relieve pain: Acetaminophine"<<endl;
cout<<"2. NSAIDs and Steroids to relieve pain and reduce inflammation: take Ibuprofen and
ASA \n";

```

```

cout<<"3. DMARDs to releive pain and slow joint damage: methotrexate"<<endl;
cout<<"4. Biologic Response Modifier: to releive pain and inflammation and also to prevent
damage to the joints \n";
}
}
else
{
cout<<"It is not the case of rheumatoid arthritis. Consider the case of  1. SLE  2. Scleroderma  3.
Polymyositis \n";

}

}

void SLE()
{
int i=0;
char BR, PS, MN_u, Swollen_LN, AB_DNA, ANA_blood, Dis_rash;
cout<<"Answer the following queries in order to confirm the type. Enter Y/N: \n";
cout<<"Does patient has butterfly rash (rash on the bridge of nose and cheeks)? \n";
cin>>BR;
if(BR=='Y' || BR=='y')
{
i=i+1;
}
cout<<"Discoid rash(Raised red patches on the skin)? \n";
cin>>Dis_rash;
if(Dis_rash=='Y' || Dis_rash=='y')
{
i=i+1;
}
cout<<"Sensitivity to sunlight or photosensitivity? \n";
cin>>PS;
if(PS=='Y' || PS=='y')
{
i=i+1;
}
cout<<"Mouth or nose ulcers? \n";
cin>>MN_u;
if(MN_u=='Y' || MN_u=='y')
{
i=i+1;
}
cout<<"Antibodies in DNA? \n";
cin>>AB_DNA;
if(AB_DNA=='Y' || AB_DNA=='y')
{
i=i+1;
}
cout<<"ANA present in the blood? \n";
cin>>ANA_blood;

```

```

if(ANA_blood=='Y' || ANA_blood=='y')
{
    i=i+1;
}
cout<<"Swollen lymph nodes? \n";
cin>>Swollen_LN;
if(Swollen_LN=='Y' || Swollen_LN=='y')
{
    i=i+1;
}
if(i>=4)
{
    cout<<"This is the case of SLE [Systemic Lupus Erythmatosus] \n";
    cout<<"Go for the following tests: \n";
    cout<<"1. Antibody Tests including ANA panel \n2. CBC \n3. Chest X-ray \n4. Kidney Biopsy \n5. Urinalysis \n";
    cout<<"If found positive than follow the below procedures: \n";
    cout<<"Treatments for SLE: \n";
    cout<<"\t1. NSAIDs to reduce the inflammation responsible for the stiffness and discomfort in your muscle, joints and other tissues. \n\t2. Antimalarial Drugs-Plaquenil [hydroxychloroquine]: medicine for malarial helps in controlling lupus. \n";
    cout<<"\t3. Corticosteroids: Prednisone and other types of corticosteroids can counter the inflammation of Lupus. \n\t4. Immune Supressants: such as BELIMUMAB (Benlysta), Mycophenolate Mofetil, Cyclosporine, Cytoxan, Imuran, Methotrexate. But these are used in very serious cases of lupus i.e., when lupus is very active \n";
    cout<<"\n\t Various medications for skin condition related to Lupus \n";
    cout<<"Also there are some pecautions that needs to be taken when suffering from SLE \n";
    cout<<"\n\t1. Wear protective clothing, sunglasses and sunscreen when in the sun. \n\t2. Get preventive heart care. \n\t3. Stay upto date with immunizations \n\t4. Have tests to screen for thinning of the bones i.e., OSTEOPOROSIS \n";
}
else
{
    cout<<"This is not the case of SLE \n";
    cout<<"consider 1. Scleroderma  2. Polymyositis \n";
    Scleroderma();
}
}
void Scleroderma()
{
    int i=0;
    char sk,bm,bp,ch;
    cout<<"Enter the type of scleroderma? Choose one of the following: sk/bm/bp ? \n";
    cin>>ch;
    switch(ch)
    {
        case 'sk':
            char ray_ph, hst, stif_tigh, white_lum, ulcer, tigh_mas;
            cout<<"Does patient's fingers or toes turn blue or white in response to hot and cold temperatures i.e., Raynaud's Phenomenon \n";
            cin>>ray_ph;
    }
}

```

```

if(ray_ph=='Y'||ray_ph=='y')
{
i=i+1;
}
cout<<"Patient suffering from hair loss, skin hardness or thickening? \n";
cin>>hst;
if(hst=='Y'||hst=='y')
{
i=i+1;
}
cout<<"Stiffness and tightness in the skin of fingers, hands and forearms? \n";
cin>>stif_tigh;
if(stif_tigh=='Y'||stif_tigh=='y')
{
i=i+1;
}
cout<<"Does patient has some small white lumps beneath the skin that sometimes ooze a white substance that looks like toothpaste? \n";
cin>>white_lum;
if(white_lum=='Y'||white_lum=='y')
{
i=i+1;
}
cout<<"Does patient has sores or ulcers on the fingertips or toes? \n";
cin>>ulcer;
if(ulcer=='Y'||ulcer=='y')
{
i=i+1;
}
cout<<"Does patient has tight and mask like skin on the face? \n";
cin>>tigh_mas;
if(tigh_mas=='Y'||tigh_mas=='y')
{
i=i+1;
}
if(i>=3)
{
cout<<"This is a scenerio of Skin scleroderma \n";
cout<<"Inflammation can be confirmed by one of the following tests: \t1. ANtinuclear Antibody panel \t2. Antibody testing \t3. ESR(sed rate) \t4. Rheumatoid factor \n";
cout<<"Treatment for Skin scleroderma: \n";
cout<<"\t1. Medicines used to treat scleroderma are corticosteroids. \nDrugs that supress teh immune system such as methotrexate and cytoxan \n";
cout<<"\t2.Light therapy to releive skin thickening \n";
cout<<"\t3. Medicines to treat Raynaud's phenomenon \n";
cout<<"\t4. Treatment usually involves physical therapy \n";
}
break;
case 'bm': char jp,npf, pss, wp;
cout<<"Is patient suffeirng from joint pain? Enter Y/N \n";
cin>>jp;
if(jp=='Y'||jp=='y')

```

```

    {i=i+1;
    }
    cout<<"Numbness and pain in the feet? Enter Y/N \n";
    cin>>npf;
    if(npf=='Y' || npf=='y')
    {i=i+1;
    }
    cout<<"Pain, stiffness and swelling of fingers and joints? Enter Y/N \n";
    cin>>pss;
    if(pss=='Y' || pss=='y')
    {i=i+1;
    }
    cout<<"Wrist pain \n";
    cin>>wp;
    if(wp=='Y' || wp=='y')
    {i=i+1;
    }
    if(i>=2)
    {cout<<"This is a case of Bone and muscles scleroderma \n";
    cout<<"Inflammation can be confirmed by one of the following tests: \t1. ANtinuclear Antibody
    panel \t2. Antibody testing \t3. ESR(sed rate) \t4. Rheumatoid factor \n";
    cout<<"Treatment for bone and muscle scleroderma: \n";
    cout<<"\t1. Medicines used to treat scleroderma are corticosteroids. \nDrugs that supress teh
    immune system such as methotrexate and cytoxan \n";
    }
    break;
    case 'bp': char dc, short_brth, wh;
    cout<<"Breathing problems may result from scarring in the lungs \n";
    cout<<"Dry cough? Enter Y/N \n";
    cin>>dc;
    if(dc=='Y' || dc=='y')
    {i=i+1;
    }
    cout<<"Shortness of breath? Enter Y/N \n";
    cin>>short_brth;
    if(short_brth=='Y' || short_brth=='y')
    {i=i+1;
    }
    cout<<"Wheezing? Enter Y/N \n";
    cin>>wh;
    if(wh=='Y' || wh=='y')
    {i=i+1;
    }
    if(i>=2)
    {cout<<"This is a scenerio of Scleroderma breathig problems \n";

```



```

cout<<"Inflammation can be confirmed by one of the following tests: \t1. ANtinuclear Antibody
panel \t2. Antibody testing \t3. ESR(sed rate) \t4. Rheumatoid factor \n";
cout<<"Treatment for breathing problems scleroderma: \n";
cout<<"\t1. Medicines used to treat scleroderma are corticosteroids. \nDrugs that supress teh
immune system such as methotrexate and cytoxan \n";
cout<<"\t2.Medicines for heartburn or swallowing problems. \n";
cout<<"\t3. Blood pressure medications [such as ACE inhibitors] \n";
cout<<"\t4. Medicines to improve breathing [Bosentan] \n";
}
break;
default:      cout<<"This is not a case of Scleroderma \n";
break;

}
void scleroderma();
}
void Polymyositis()
{int i=0;
char gra_on, diff_ris,torso_wk, dys, pwj, gf;
cout<<"Graudal onset of weakness over weeks or months? Enter Y/N \n";
cin>>gra_on;
if(gra_on=='Y' || gra_on=='y')
{i=i+1;

}
cout<<"Does patient has difficulty in rising from a low-seated chair or combing one's hair? Enter
Y/N \n";
cin>>diff_ris;
if(diff_ris=='Y' || diff_ris=='y')
{i=i+1;
}
cout<<"Does patient has torso or core weakness? Enter Y/N \n";
cin>>torso_wk;
if(torso_wk=='Y' || torso_wk=='y')
{i=i+1;
}
cout<<"Does patient has difficulty swallowing (or dysphagia)? Enter Y/N \n";
cin>>dys;
if(dys=='Y' || dys=='y')
{i=i+1;
}
cout<<"Does the patient has pain or weakness in the joints? Enter Y/N \n";
cin>>pwj;
if(pwj=='Y' || pwj=='y')
{i=i+1;
}
}

```

```

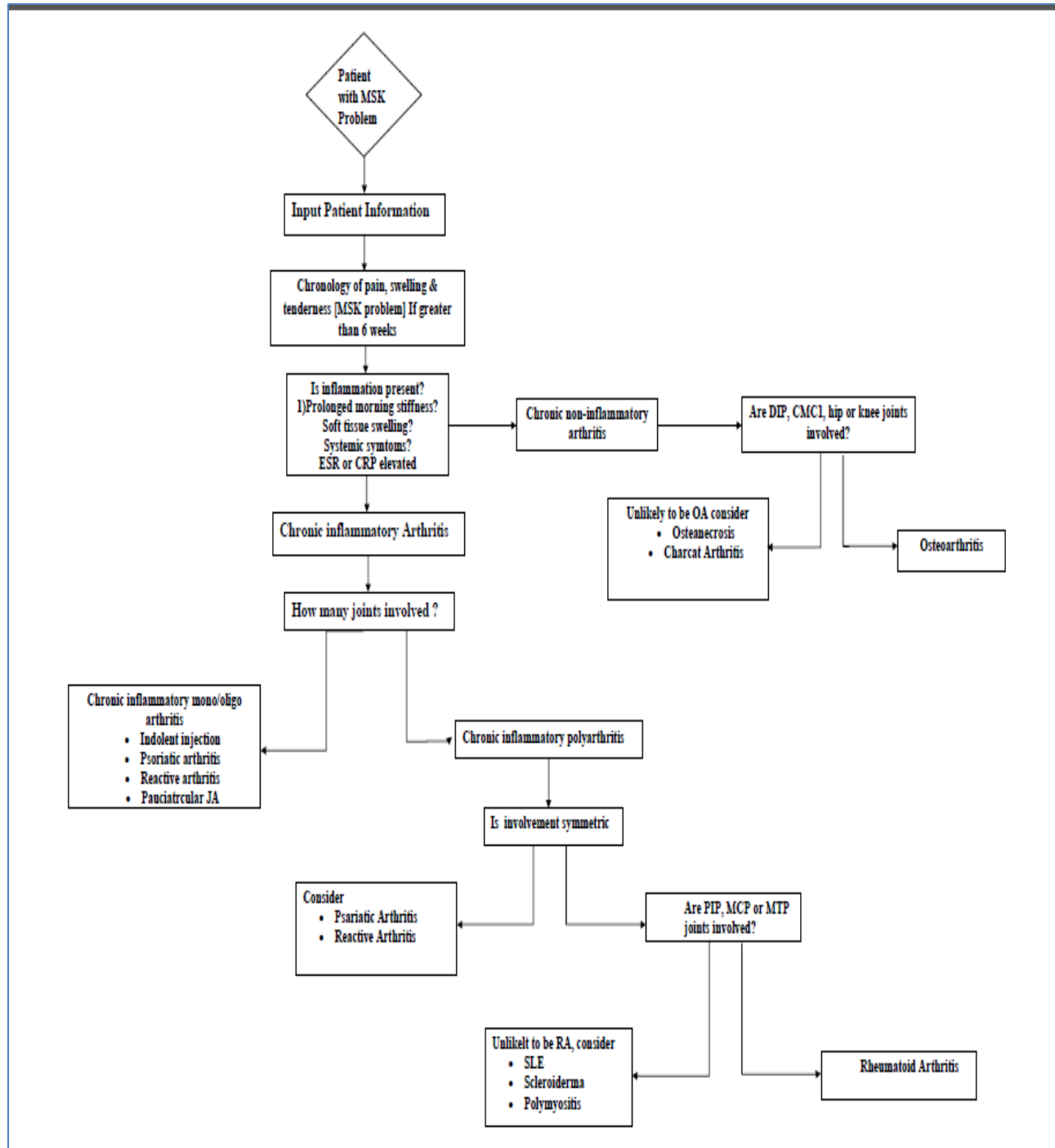
cout<<"Is patient suffering from generalized fatigue? Enter Y/N \n";
cin>>gf;
if(gf=='Y'||gf=='y')
{
i=i+1;
}
if(i>=3)
{
cout<<"This is a scenerio of Polymyositis \n";
cout<<"Inflammation can be confirmed by one of the following tests: \n\t1. Autoimmune
antibodies and inflammation tests \n\t2. CPK \n\t3. Electromyography \n\t4. MRI of affected
muscles \n\t5. Muscle Biopsy \n\t6. Myoglobin in the urine \n\t7. Serum Aldolase \n";
cout<<"Treatment for Polymyositis as follows: \n";
cout<<"\n\t1. Corticosteroids medicines: The dose of medicine is slowly tapered off as muscle
strength improves. This takes about 4-6 weeks. You will stay on a low dose of a corticosteroid
medicine after that. Medicines to suppress the immune system, such as methotrexate and
azathioprine, may be used for people who do not respond to corticosteroids. \n";
cout<<"\n\t2. Intravenous gamma globulin has been tried, with mixed results. Biologic drugs
also may play in part in treating this condition but it is too soon to know. \n";
cout<<"\n\t3. If the condition is associated with a tumor, it may improve if the tumor is removed.
\n";
}
else
{
cout<<"This is not a case of Polymyositis. Consider 1. SLE 2. Scleroderma \n";
SLE();
}
}
}

```

Chapter 5

RESULTS AND DISCUSSIONS

5.1 Algorithm:



5.2 Case Study:

Three case studies were done on this arthritis platform as shown below:

1. Patient suffering from Rheumatoid arthritis with the given symptoms:

- a. Pain, swelling and tenderness in bone for more than 6 weeks.

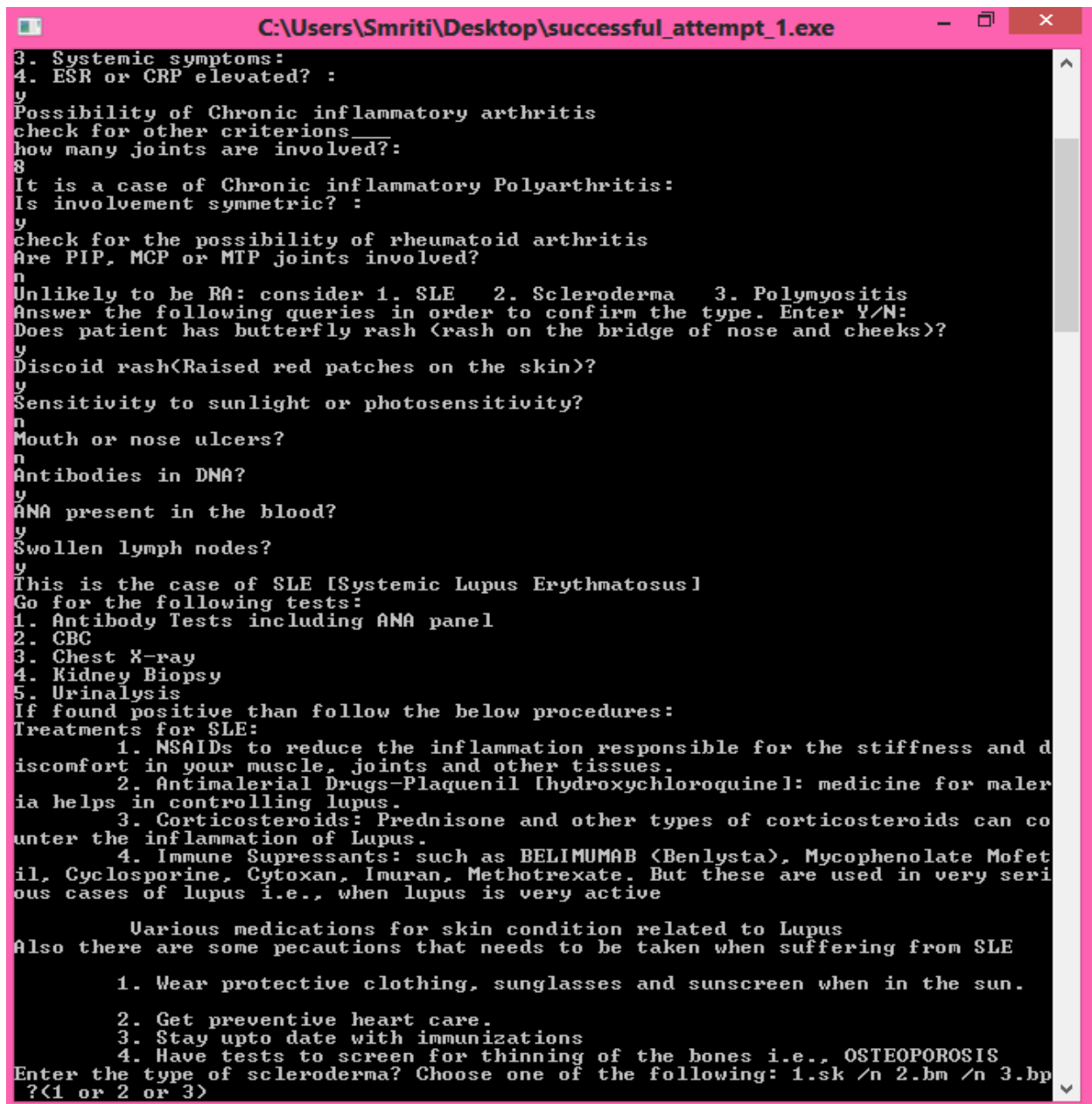
- b. Inflammation present**
 - i. Prolonged morning stiffness**
 - ii. Soft tissue swelling**
 - iii. Systemic symptoms**
 - iv. ESR or CRP elevated**
- c. Around 7 joints are involved.**
- d. Symmetric involvement of PIP, MCP and MTP joints**
- e. Presence of rheumatoid nodules on the surface of skin**
- f. Weight loss, general weakness and loss of appetite.**

```
C:\Users\Smriti\Desktop\successful_attempt_1.exe
Enter Patient details
1. Patient's name:
Smriti Bhatt
2. Gender:
Female
3. Race:
Indian
4. Age:
22
articulation involvement?
Enter Yes/No:
y
Pain, swelling and tenderness in bone involved
Is suffering more than 6 weeks?
y
Is inflammation present?
Check for inflammation:
1. Prolonged Morning sickness?
2. Soft Tissue swelling?
3. Systemic symptoms:
4. ESR or CRP elevated? :
y
Possibility of Chronic inflammatory arthritis
check for other criterions____
how many joints are involved?:
7
It is a case of Chronic inflammatory Polyarthrititis:
Is involvement symmetric? :
y
check for the possibility of rheumatoid arthritis
Are PIP, MCP or MTP joints involved?
y
It is Rheumatoid Arthritis
check for the symptoms of Rheumatoid Arthritis:
Enter Y/N for the below queries:
Is patient suffering from Joint Inflammation?
y
Pain, swelling, tenderness and reddishness in joints?
y
Symmetry in inflammation or Joints on both the sides of the body are affected?
y
Skin for rheumatoid nodules?
y
Weight loss, general weakness and loss of appetite?
n
It is rheumatoid arthritis. Kindly go for the listed tests to confirm it properly
y
1. Rheumatoid Factor test    2. Anti-CCP antibody test
p
p
Follow the below procedure for the treatment of Rheumatoid Arthritis:
1. Analgesics to relieve pain: Acetaminophen
2. NSAIDs and Steroids to relieve pain and reduce inflammation: take Ibuprofen and ASA
3. DMARDs to relieve pain and slow joint damage: methotrexate
4. Biologic Response Modifier: to relieve pain and inflammation and also to prevent damage to the joints
```

Figure 4: Output interface for case study 1 [Rheumatoid Arthritis]

2. Patient suffering from Systemic Lupus Erythematosus [SLE] with the symptoms given below:

- a. Pain, swelling and tenderness in bone for more than 6 weeks.
- b. Around 8 joints are involved
- c. Symmetric involvement
- d. Patient has butterfly rash
- e. Discoid rash
- f. Antibodies in DNA
- g. ANA present in the blood
- h. Swollen lymph nodes

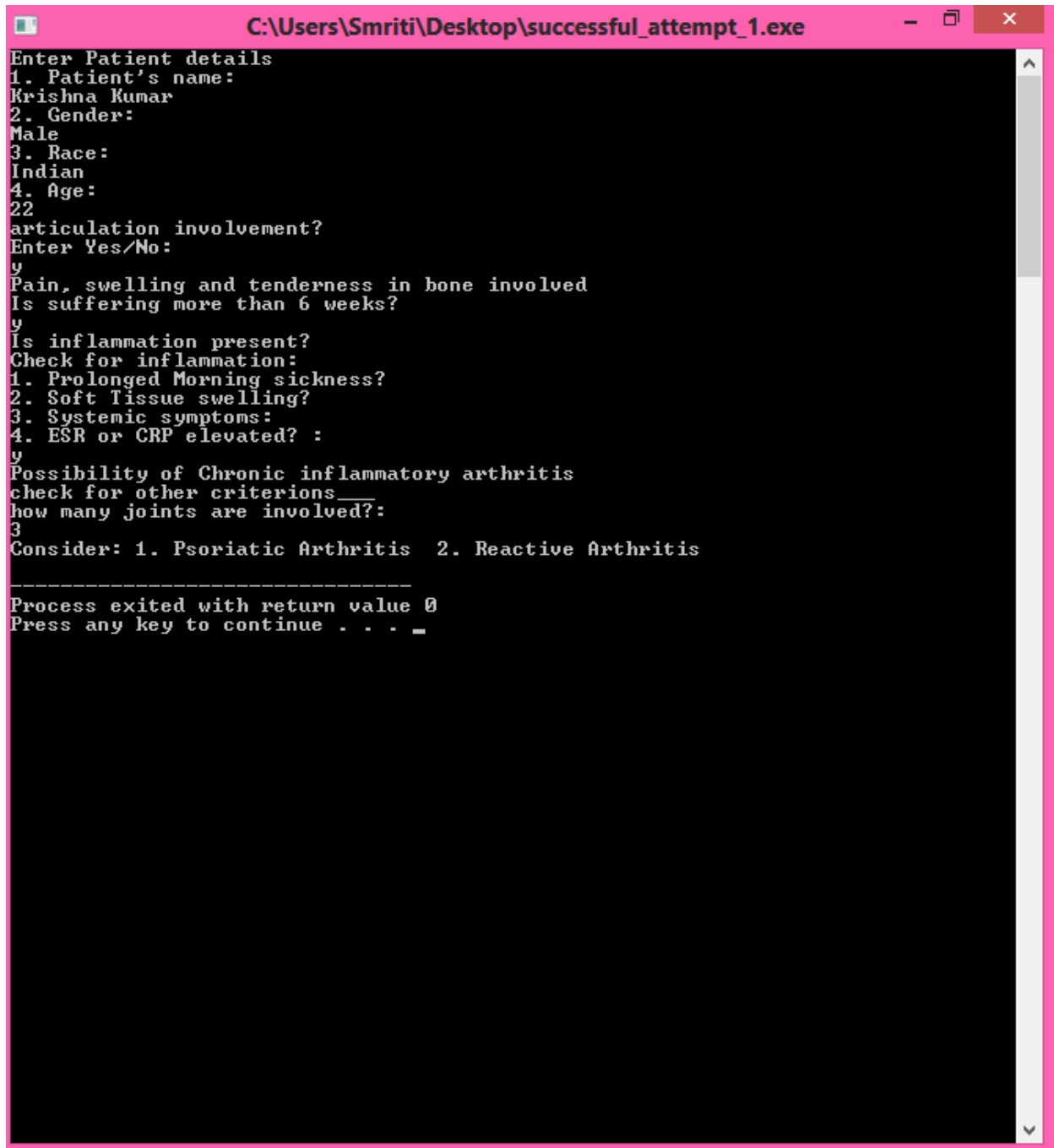


```
C:\Users\Smriti\Desktop\successful_attempt_1.exe
3. Systemic symptoms:
4. ESR or CRP elevated? :
y
Possibility of Chronic inflammatory arthritis
check for other criterions___
how many joints are involved?:
8
It is a case of Chronic inflammatory Polyarthritiis:
Is involvement symmetric? :
y
check for the possibility of rheumatoid arthritis
Are PIP, MCP or MTP joints involved?
n
Unlikely to be RA: consider 1. SLE 2. Scleroderma 3. Polymyositis
Answer the following queries in order to confirm the type. Enter Y/N:
Does patient has butterfly rash (rash on the bridge of nose and cheeks)?
y
Discoid rash(Raised red patches on the skin)?
y
Sensitivity to sunlight or photosensitivity?
n
Mouth or nose ulcers?
n
Antibodies in DNA?
y
ANA present in the blood?
y
Swollen lymph nodes?
y
This is the case of SLE [Systemic Lupus Erythmatosus]
Go for the following tests:
1. Antibody Tests including ANA panel
2. CBC
3. Chest X-ray
4. Kidney Biopsy
5. Urinalysis
If found positive than follow the below procedures:
Treatments for SLE:
1. NSAIDs to reduce the inflammation responsible for the stiffness and d
iscomfort in your muscle, joints and other tissues.
2. Antimalarial Drugs-Plaquenil [hydroxychloroquinel: medicine for maler
ia helps in controlling lupus.
3. Corticosteroids: Prednisone and other types of corticosteroids can co
unter the inflammation of Lupus.
4. Immune Supressants: such as BELIMUMAB (Benlysta), Mycophenolate Mofet
il, Cyclosporine, Cytoxan, Imuran, Methotrexate. But these are used in very seri
ous cases of lupus i.e., when lupus is very active

Various medications for skin condition related to Lupus
Also there are some pecautions that needs to be taken when suffering from SLE
1. Wear protective clothing, sunglasses and sunscreen when in the sun.
2. Get preventive heart care.
3. Stay upto date with immunizations
4. Have tests to screen for thinning of the bones i.e., OSTEOPOROSIS
Enter the type of scleroderma? Choose one of the following: 1.sk /n 2.bm /n 3.bp
?<1 or 2 or 3>
```

Figure 5: Output interface for case study2 [SLE]

3. Patient suffering from psoriatic arthritis or reactive arthritis with the given symptoms:
- Pain, swelling and tenderness in bone for more than 6 weeks
 - Prolonged morning stiffness, Soft tissue swelling, systemic symptoms and ESR or CRP elevated
 - Around 3 joints are involved



```
C:\Users\Smriti\Desktop\successful_attempt_1.exe
Enter Patient details
1. Patient's name:
Krishna Kumar
2. Gender:
Male
3. Race:
Indian
4. Age:
22
articulation involvement?
Enter Yes/No:
y
Pain, swelling and tenderness in bone involved
Is suffering more than 6 weeks?
y
Is inflammation present?
Check for inflammation:
1. Prolonged Morning sickness?
2. Soft Tissue swelling?
3. Systemic symptoms:
4. ESR or CRP elevated? :
y
Possibility of Chronic inflammatory arthritis
check for other criterions___
how many joints are involved?:
3
Consider: 1. Psoriatic Arthritis 2. Reactive Arthritis

-----
Process exited with return value 0
Press any key to continue . . . _
```

Figure 6: Output screen for case study 3 [reactive arthritis]

Chapter 6

CONCLUSIONS:

This platform was effectively used for various case studies on virtual people to confirm the validation of results. Examples of three case studies are given above:

Case study1: For a patient suffering from Rheumatoid Arthritis

Case study2: For a patient suffering from Systemic Lupus Erythmatosus [SLE].

Case study3: For a patient suffering from Reactive Arthritis

Results were validated accordingly. Thus in the current project an interactive tool based on C++ programming platform was successfully designed and validated for real time differential diagnosis of arthritis cases. This tool integrated with a comprehensive clinical database of an array of arthritis cases can be used as a decision making system for medical professionals.

FUTURE WORK:

- This platform was effectively used for various case studies on virtual people to confirm the validation of results.
- This platform can further be used to construct an embedded system for the diagnosis of Arthritis for household purposes or may be used in rural areas where doctors are not easily available.
- A Graphical User Interface can be created using this program for more interactive user interface and easily accessible. This type of application is more users interactive and easy to deal with particularly in the field of arthritis which is a very vast field and still lacking in studies and research. Computerized application is far less complicated procedure in order to discriminate different types of arthritis.

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